REMARKS

In the last Office Action, claims 1-3, 5-7 and 38 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita (US 5,956,565) in view of Hamamura (US 6,303,932) and Matsui (US 5,229,607). Claim 4 was rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view Hamamura and Matsui and further in view of Kane. Claim 8 was rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view of Hamamura and Matsui and further in view of Yang. Claims 31-32 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view of Hamamura and Matsui and further in view of Hantschel. Claims 33-34 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view of Hamamura and Matsui and further in view of Okazaki. Claims 33 and 35 were rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view of Hamamura and Matsui and further in view of Japanese Patent No. 10-223170 to Hitachi. Claim 37 was rejected under 35 U.S.C. §103(a) as being unpatentable over Yamashita in view of Hamamura and Matsui and further in view of Azuma.

Applicants respectfully traverse the prior art rejections of claims 1, 3-8, 31-35, 37 and 38 over the various combinations of the references to Yamashita, Hamamura, Matsui, Kane, Yang, Hantschel, Okazaki, Hitachi, and Azuma, and

request reconsideration of their application without further amendment to the claims.

The present invention relates to a method of cross-sectional processing and observation.

As described in the specification (pgs. 2-3), a conventional method related to the method of the present invention involves the formation of a cross-sectional exposed portion in a desired area in a sample surface and observation of the exposed cross-sectional portion through a scanning ion microscope image using a focused ion beam or a scanning electron microscope (SEM) image using an electron beam. However, such conventional method has been associated with the problem of insufficient resolution for observation as a result of using the scanning ion beam microscope image or SEM image. The specific problem is that the resolution is insufficient to manage the very small thickness of the film structures being observed.

Another conventional method involves etching a desired area in a sample surface with a focused ion beam to take out a sample chip and observing the sample chip with a transmission electron microscope (TEM). However, this method has been determined to be time consuming and expensive to carry out.

Moreover, the foregoing conventional methods have only been capable of providing information on the geometry of a sample, not on electrical and mechanical characteristics of the sample.

The present invention overcomes the drawbacks of the conventional art. Figs. 1-2 show an embodiment of a method of cross-sectional processing and observation according to the present invention embodied in independent claim 1. According to the method of the present invention, in a first step at least one predetermined area 13 in a surface of a sample 12 is processed to form a target cross-section by etching the at least one predetermined area 13 with a focused energy beam using a focused energy beam irradiating unit 1 in a vacuum chamber 3. In a second step, the target cross-section is observed by scanning the target cross-section with a probe of a scanning probe microscope 6 in the vacuum chamber and detecting a physical quantity produced between the probe and the target cross-section.

Another embodiment of a method of cross-sectional processing and observation requires the removal of a damaged portion (region 15) remaining in the exposed target cross-section and the subsequent formation of a stepped portion 16 according to a difference in materials among layers forming the exposed target cross-section.

By the foregoing methods, a sufficient spatial resolution for observing the formed or exposed target cross-section of the sample is achieved as compared to the conventional art. Furthermore, the methods according to the present invention facilitate the acquisition of electric, magnetic, and mechanical information for a target sample plane.

The cited references to Yamashita, Hamamura, Matsui, Kane, Yang, Hantschel, Okazaki, Hitachi, and Azuma, either alone or in combination, do not disclose or suggest the combination of steps recited in pending claims 1, 3-8, 31-35 and 37-38.

Independent claims 1 and 5 were rejected under 35 U.S.C. §103(a) as being unpatentable over the combined teachings of Yamashita, Hamamura and Matsui. Applicants respectfully traverse this rejection.

Independent claim 1 recites a method of cross-sectional processing and observation and requires a first step of processing at least one predetermined area in a surface of a sample to form a target cross-section by etching the at least one predetermined area with a focused energy beam using a focused energy beam irradiating unit in a vacuum chamber, and a second step of observing the target cross-section by scanning the target cross-section with a probe of a scanning probe microscope in the vacuum chamber and detecting a

physical quantity produced between the probe and the target cross-section. No corresponding steps are disclosed or suggested by the prior art of record.

The primary reference to Yamashita discloses a method for observing the cross-section of a sample using an AFM apparatus in a vacuum, the AFM apparatus being connected to an FIB apparatus via a gate valve 15 (Fig. 1; col. 5, lines 50-53). As shown in Figs. 4(a)-4(d), the sample is diced, an unevenness is formed on the wall of the diced sample using the FIB, and the wall surface is observed using the AFM. This procedure requires the diced sample to be exposed to ambient air after application of the FIB.

In contrast, independent claim 1 recites a first step of processing at least one predetermined area in a surface of a sample to form a target cross-section by <u>etching the at least one predetermined area with a focused energy beam using a focused energy beam irradiating unit in a vacuum chamber</u>, and a second step of <u>observing the target cross-section by scanning the target cross-section with a probe of a scanning probe microscope in the vacuum chamber</u>. Stated otherwise, in independent claim 1 both the processing of the surface of the sample and the observation of the processed surface of the sample take place in a vacuum chamber (i.e., the same vacuum chamber), and there is no exposure of the sample to ambient air during or between these steps.

The secondary reference to Hamamura discloses a method and apparatus for detecting a secondary electron beam image including a focused ion beam lens column 1 in the form of a scanning ion microscope (SIM) which is used for observation (Fig. 1), positive ion beam supply means 20, and a contact probe 30. The secondary reference to Matsui discloses the combination of an FIB device with a microscope in a single apparatus (col. 11, lines 22-25 and Fig. 9). The Examiner contends that it would have been obvious to one of ordinary skill in the art, at the time the invention was made, to modify Yamashita with the teachings of Hamamura and Matsui as set forth above in order to arrive at the claimed invention. Applicants respectfully disagree with the Examiner's contention.

In Hamamura, SIM is disposed in a vacuum chamber 5 (i.e., vacuum system sample room). However, contrary to the Examiner's contention, Hamamura does not disclose or suggest any processing device disposed in the same vacuum chamber 5 in which the SIM is disposed. More specifically, the positive ion beam supply means 20 in the vacuum chamber 5 of Hamamura does not provide the specific processing function (i.e., etching at least one predetermined area in a surface of a sample with a focused energy beam) required by the "processing" step recited in claim 1. In Hamamura, the function of the positive ion beam supply means 20 is to

prevent charge build-up at an insulating film on the surface of a specimen (col. 7, lines 23-28). Likewise, the contact probe 30 in the vacuum chamber 5 of Hamamura functions to release to the ground electric charge accumulated by the irradiation of an ion beam 22 (col. 47-52) and, therefore, does not provide the specific function of the focused energy beam irradiating unit required by the "processing step" of independent claim 1.

Thus, while Matsui discloses the combination of an FIB device with a microscope in a single apparatus, modification of Yamashita with the teachings of Hamamura and Matsui as proposed by the Examiner would not lead to the claimed invention recited in independent claim 1 because Hamamura does not teach carrying out a processing operation by a processing device in a vacuum chamber.

Moreover, applicants respectfully submit that there is no proper motivation to combine the references in the manner proposed by the Examiner to arrive at the claimed invention. For example, the Examiner contends that the motivation for modifying Yamashita with the teachings of Hamamura is that Hamamura allows for obtaining a high resolution image (col. 2, line 46). However, the SIM of Hamamura is an FIB (focused ion beam) apparatus, not an SMP (scanning probe microscope). Likewise, the contact probe 30 is not a probe of an SPM, and the positive ion beam supply

means 20 is not for observing a specimen. Thus, contrary to the Examiner's contention, Hamamura does not provide any motivation for achieving a high resolution image and, therefore, there is no motivation to combine the teachings of Yamashita, Hamamura and Matsui in the manner proposed by the Examiner to arrive at the claimed invention.

Accordingly, Hamamura and Matsui do not cure the deficiencies of Yamashita, and one of ordinary skill in the art would not have been led to modify the references to attain the claimed subject matter.

As recognized by the Examiner, the remaining secondary references to Kane, Yang, Hantschel, Okazaki, Hitachi, and Azuma do not cure the deficiencies of Yamashita as modified by Hamamura and Matsui. Accordingly, one of ordinary skill in the art would not have been led to modify these references to arrive at the claimed invention.

Independent claim 5 is also directed to a method of cross-sectional processing and observation and requires the steps of providing a system for cross-sectional processing and observation comprised of a processing unit for processing a surface of a sample and a scanning probe microscope unit both disposed in a single vacuum chamber, processing at least one predetermined area in the surface of the sample using the processing unit to expose a target cross-section thereof, and observing the exposed target cross-section by scanning the

exposed target cross-section with a probe of the scanning probe microscope unit. No corresponding combination of steps is disclosed or suggested by the prior art of record as set forth above for independent claim 1.

Claims 3, 4, 8, 31-35 and 6, 7, 37, 38 depend on and contain all of the limitations of independent claims 1 and 5, respectively, and, therefore, distinguish from the prior art of record at least in the same manner as claims 1 and 5.

In view of the foregoing, applicants respectfully request that the rejections of claims 1, 3-8, 31-35, 37 and 38 under 35 U.S.C. §103(a) as being unpatentable over various combinations of the references to Yamashita, Hamamura, Matsui, Kane, Yang, Hantschel, Okazaki, Hitachi, and Azuma be withdrawn.

In view of the foregoing discussion, the application is believed to be in allowable form. Accordingly, favorable reconsideration and allowance of the claims are most respectfully requested.

Respectfully submitted,

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